

## **Appendix G**

### **Ecological Evaluation Toxicity Reference Values**

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## **Appendix G**

### **Ecological Evaluation Toxicity Reference Values**

Tables G-1 and G-2 below present summaries of the toxicity reference values used to estimate risks associated with ecological receptors (see Section 7). The data that follow the two summary tables include data used to develop TRVs for individual contaminants.



**Table G-1.** Summary of selected toxicity reference values (TRVs in mg/kg-day) for mammalian functional groups.

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
1,1-Dichloroethylene (Rat-NOAEL)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.8	3.8
1,1,1 Trichloroethane (Mouse - NOAEL)	333	333	333	333	333	333	333	333	500	500
1,1,2,2-Tetrachloroethane (Mouse - FEL)	7.89	7.89	7.89	7.89	7.89	7.89	7.89	7.89	11.8	11.8
1,2,4-Trichlorobenzene (Rat - NOAEL)	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.83	0.83
2-Butanone (Rat - NOAEL)	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	442.8	442.8
2-Chlorotoluene (Rat - NOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0
2-Methylnaphthalene <sup>f</sup> (Rat - Cancer)	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>	<sup>f</sup>
2-Propanol (Mouse - NOAEL)	217	217	217	217	217	217	217	217	325	325
2,3,7,8-Tetrachlorodibenzodioxin (Rat - NOAEL)	3E-8	3E-8	3E-8	3E-8	3E-8	3E-8	3E-8	3E-8	5E-8	5E-8
2,4-Dichlorophenoxyacetic acid (Rat and Mouse - NOAEL)	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.25	0.25
2,4- Dimethylphenol (Mouse - NOAEL)	17	17	17	17	17	17	17	17	25	25
2,4-Dinitrotoluene (Dog - NOAEL)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.10
4-Chloroaniline (Rat and Moose - LOAEL)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.78	0.78
4-Methylphenol (p-Cresol) (Rat - NOAEL)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	13	13
4-Chloro-3-methylphenol (CMP) (Rat - NOAEL)	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	8.3	8.3
Acenaphthene (Mouse - NOAEL)	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	21.9	21.9
Acetone (Mouse and Rat - NOAEL)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	13	13
Acetonitrile <sup>a</sup> (Rat - NOAEL)	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>

**Table G-1. (continued).**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Acrylonitrile (Rat - NOAEL)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.14	0.14
Aluminum (Bovine - NOAEL)	1.28	1.28	1.28	1.28	0.85	0.85	0.85	0.85	0.85	0.85
Aluminum chloride (Bovine - NOAEL)	4.82	4.82	4.82	4.82	3.21	3.21	3.21	3.21	3.21	3.21
Aluminum hydroxide (Rat - AEL)	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	18.5	18.5
Aluminum nitrate (Rat - LOAEL)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	7.5	7.5
Ammonia (Rat - LD <sub>50</sub> )	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.2	2.2
Anthracene (Mouse - NOAEL)	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	62.5	62.5
Antimony (Mouse - NOAEL)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.35	0.35
Arsenic (Dog - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.32
Asbestos (Rat - LOAEL)	6578	6578	6588	6578	6578	6578	6578	6578	9867	9867
Barium (Rat - NEL)	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	71.2	71.2
Barium chloride (Rat - NOAEL)	5.81	5.81	5.81	5.81	5.81	5.81	5.81	5.81	8.71	8.71
Benzene (Mouse - LOAEL)	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	5.49	5.49
Benzine <sup>d</sup> (Mouse - LD <sub>50</sub> )	d	d	d	d	d	d	d	d	d	d
Benzo(a)anthracene (Mouse - FEL)	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	14	14
Benzo(a)pyrene (Mouse-Cancer)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Benzo(b)fluoranthene (BbF) (Mouse - LOAEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Beryllium (Rat - NOAEL)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.33	0.33
Bis(tri-n-butyltin)oxide (Mouse - LD <sub>50</sub> )	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	1.0	1.0
Boron (Dog - NOAEL)	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	2.19	4.37
Butyl alcohol (n-Butanol) (Rat - NOAEL)	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	31.3	31.3
Butylbenzylphthalate (BBP) (Rat - NOAEL)	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	6.63	6.63
Cadmium (Rat - LOAEL)	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	1E-3	1E-3

**Table G-1.** (continued).

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Carbon disulfide <sup>a</sup> (Rabbit and Rat – NOAEL)	a	a	a	a	a	a	a	a	a	a
Carbon Tetrachloride (Rat – NOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0
Cerium chloride (Rat - FEL)	8.68	8.68	8.68	8.68	8.68	8.68	8.68	8.68	13.03	13.03
Chloride (Mouse - FEL)	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	4.41	4.41
Chloroform (Dog - NOAEL)	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.61	3.23
Chromium(III) (Rat – NOAEL)	250	250	250	250	250	250	250	250	375	375
Chromium(VI) (Dog – NOAEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.15
Chryseneb (Mouse – LOAEL)	b	b	b	b	b	b	b	b	b	b
Cobalt (Dog - NOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.1	4.2
Copper (Mink - NOAEL)	0.437	0.437	0.437	0.437	0.437	0.437	0.437	1.31	0.437	0.437
Cyanide (Rat - NOAEL)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	2.70	2.70
Diethyl phthalate (Rat – NOAEL)	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	93.8	93.8
Di-2-ethylhexyl-phthalate (DEHP) (Guinea Pig – LOAEL)	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	1.2	1.2
Di-n-butylphthalate (Rat - NOAEL)	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	6.94	6.94
Di-n-octylphthalate (Rat - LOAEL)	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	21.8	21.8
Ethanol (Rat - LOAEL)	2.66	2.66	2.66	2.66	2.66	2.66	2.66	2.66	3.99	3.99
Ethylbenzene (Rat - LOAEL)	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	25.5	25.5
Fluoranthene (Mouse - NOAEL)	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	15.6	15.6
Fluorene (Mouse – LOAEL)	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	15.6	15.6
Fluoride (Mink – NOAEL)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	31.4	10.5	10.5
Formaldehyde (Beagle Dog - NOAEL)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	1.2	2.4
Hexachlorobenzene (Mink - NOAEL)	3	3	3	3	3	3	3	1	3	3



**Table G-1. (continued).**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Hydrazine (Mouse - NOAEL)	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	1.4	1.4
Hydrofluoric acid <sup>a</sup> (Mouse - FEL)	a	a	a	a	a	a	a	a	a	a
Lead (Rat - NOAEL)	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	4.0	4.0
Magnesium (Sheep - NOAEL)	2.2	2.2	2.2	2.2	1.4	1.4	1.4	1.4	1.4	1.4
Manganese (Rat - NOAEL)	29	29	29	29	29	29	29	29	44	44
Mercury (Inorganic) (Swine - NOAEL)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.031	0.031
Mercury (Organic) (Rat - NOAEL)	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.013	0.013
Methanol (Rat - NOAEL)	170	170	170	170	170	170	170	170	250	250
Methyl isobutyl ketone (Rat - NOAEL)	21	21	21	21	21	21	21	21	31	31
Methylene chloride (Rat - NOAEL)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	1.3	1.3
Molybdenum (Guinea pig - LOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0
n-Propylbenzene <sup>g</sup> (Mouse - LOAEL)	g	g	g	g	g	g	g	g	g	g
Naphthalene (Mouse - NOAEL)	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.66	0.66
Nickel (Dog - NOAEL)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	6.3	13
Nitrate (Rabbit - AEL)	83.21	83.21	83.21	83.21	55.47	55.47	55.47	55.47	55.47	55.47
Nitric acid (Rat - NOAEL)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5
PCBs - Aroclor 1254 (Rat - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.16
PCBs - Aroclor 1260 (Rat - NOAEL) <sup>e</sup>	e	e	e	e	e	e	e	e	e	e
Phenol (Rat - NOAEL)	13	13	13	13	13	13	13	13	20	20
Potassium chloride (Mouse - LD <sub>50</sub> )	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	9.3	9.3
Potassium hydroxide (Rat - LD <sub>50</sub> )	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.76	0.76

**Table G-1. (continued).**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Potassium nitrate (Rat - AEL)	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	1.1	1.1
Potassium phosphate (Rat - LD <sub>50</sub> )	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	8.6	8.6
Potassium sulfate (Rat - LD <sub>90</sub> )	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	15.0	15.0
Pyrene (Mouse - NOAEL)	13	13	13	13	13	13	13	13	19	19
Selenium (Rat - NOAEL)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.038	0.038
Silver (Mouse - FEL)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.3	1.3
Sodium <sup>c</sup> (Mouse - LD <sub>50</sub> )	c	c	c	c	c	c	c	c	c	c
Sodium chloride (Rat - FEL)	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	4.33	4.33
Sodium cyanide (Rat - NOAEL)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	5.1	5.1
Sodium hydroxide (Rabbit - LD <sub>50</sub> )	3.1	3.1	3.1	3.1	2.1	2.1	2.1	2.1	2.1	2.1
Sodium nitrate (Rat - FEL)	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	1.2	1.2
Sodium phosphate (Mouse - LD <sub>50</sub> )	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	24.2	24.2
Strontium (Rat - NOAEL)	32	32	32	32	32	32	32	32	48	48
Sulfate (Rat - LD <sub>90</sub> )	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	7.98	7.98
Sulfuric acid <sup>a</sup> (Guinea pig - LOAEL)	a	a	a	a	a	a	a	a	a	a
Terphenyl (Rat - LOAEL)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	3.5	3.5
Tetrachloroethylene (Mouse - NOAEL)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.8	1.8
Tetrahydrofuran <sup>b</sup> (Rat - NOAEL)	h	h	h	h	h	h	h	h	h	h
Thallium (Rat - LOAEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Tin (Rat - NOAEL)	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.72	1.72
Toluene (Rat - NOAEL)	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	27.9	27.9
Total Petroleum Hydrocarbon <sup>g</sup>	g	g	g	g	g	g	g	g	g	g
Tributyl phosphate (Rat - LD <sub>50</sub> )	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	18.5	18.5
Trichloroethylene (Rat - NOAEL)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	13	13

**Table G-1. (continued).**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Trimethylpropane-triester (Rat - LD <sub>50</sub> )	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Uranium (Mouse - NOAEL)	0.512	0.512	0.512	0.512	0.512	0.512	0.512	0.512	0.768	0.768
Vanadium (Mouse - NOAEL)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.68	0.68
Xylene (Mouse - NOAEL)	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.129	0.129
Zinc (Rat - NOAEL)	14	14	14	14	14	14	14	14	21	21
Zirconium (Rat - NOAEL)	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	298.1	298.1

a. Exposure route: inhalation.

b. Exposure route: dermal.

c. Exposure route: intraperitoneal injection.

d. Exposure route: intravenous injection.

e. The PCB, Aroclor-1254, is evaluated separately from the PCB, Aroclor-1260.

f. Values for benzo(a)pyrene were used.

g. Values for benzene were used.

h. Values for 2,3,7,8 -Tetrachlorodibenzodioxin were used.

No data were located for:

4-nitrophenol	trans-1,3-dichloropropene
benzoic acid	benzo(g,h,i)perylene
phenanthrene	pentachlorophenol
	sulfide

G-7

[illegible]

**Table G-2. (continued).**[illegible]

## 4-Chloroaniline

**COPC:** 4-Chloroaniline CAS 106-47-8

**Test Organisms:** Rat and Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL—Spleen lesions; increased mortality

**Reference:** National Cancer Institute (NCI), 1979, Bioassay of p-Chloroaniline for Possible Carcinogenicity, NCI Carcinogenesis Technical Report Series No. 189, NTIS, PB-295896.

**QCE:** 12.5 mg/kg/day—Adjusted for treatment schedule

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No juveniles tested but adult males and females tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (78-week) exposure
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Adequate number of animals from two species tested. Multiple endpoints (cancer and non-cancer) tested. Supporting studies on possible reproductive or developmental effects are lacking. A NOAEL was not established.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12.5	12.5	12.5	QCE = quantified critical endpoint
TRV	1.56	0.78	0.52	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.56	Test organism is in the same order and trophic level as the functional group members	none
2	0.78	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.52	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

## Acetone

**COPC:** Acetone CAS 67-64-1  
**Test Organisms:** Rat and Mouse (Omnivore, Order-Rodentia)  
**Exposure Medium:** Oral (gavage)  
**Test Endpoint:** NOAEL  
**Reference:** EPA, 1986, *Ninety-Day Gavage Study in Albino Rats Using Acetone*, Office of Solid Waste, Washington, DC.  
**QCE:** 100 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	30 each sex/treatment group evaluated. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (90-day) study
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Numerous endpoints measured. Adequate number of animals tested. Supporting chronic toxicity and reproductive studies are lacking.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	25	13	8.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25	Test organism is in the same order and trophic level as the functional group members	none
2	13	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

## Antimony (Antimony Potassium Tartrate)

**COPC:** Antimony (Antimony Potassium Tartrate) CAS 7440-36-0

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Water

**Test Endpoint:** NOAEL—Apparent slight decrease in life span of female CD-1 mice (significance unknown)

**Reference:** Schroeder, H.A., M. Mitchner, and J.J. Balassa, 1968, *Zirconium, Niobium, Antimony and Fluorine in Mice: Effects of Growth Survival and Tissue Levels*, Journal of Nutrition, 95:95-101.

Kanisawa, M. and H.A. Schroeder, 1969, "Life term studies on the effect of trace elements on spontaneous tumor in mice and rats." Cancer Research, 29(4):892-895.

**QCE:** 0.35 mg/kg-day—5mg/L\*7.0mL/100g-day\*L/1000mL\*1000g/1kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals.
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint could occur, but of uncertain ecological significance
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined.
M	0.5	0.5	0.5	Soluble salts in the drinking water were used
Total AF	0.5	1.0	1.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.35	0.35	0.35	QCE = quantified critical endpoint
TRV	0.70	0.35	0.23	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.70	Test organism is in the same order and trophic level as the functional group members	none
2	0.35	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.23	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322



## Arsenic

**COPC:** Arsenic CAS 7440-38-2  
**Test Organisms:** Brown-headed cowbird (Insectivore, Order-Passeriformes)  
**Exposure Medium:** NA  
**Test Endpoint:** Mortality  
**Reference:** US Fish and Wildlife Service, 1969, Bureau of Sport Fisheries and Wildlife, Publication 74, pp 56-57.  
**QCE:** 2.46 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males only.
Q <sub>1</sub>	1	1	1	Mortality
Q <sub>2</sub>	1	1	1	Chronic (7 months)
Q <sub>3</sub>	3	3	3	Mortality
U	3	3	3	Four dose levels- both a LOAEL and NOAEL established
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.46	2.46	2.46	QCE = quantified critical endpoint
TRV	0.137	0.069	0.046	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.137	Test organism is in the same order and trophic level as the functional group members	none
2	0.069	Test organism is in a different order and same trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.046	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Arsenic CAS 7440-38-2  
**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)  
**Exposure Medium:** NA  
**Test Endpoint:** LD<sub>50</sub>  
**Reference:** National Academy of Sciences (NAS), 1977, *Arsenic*, Washington DC.  
**QCE:** 39 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with little supporting variation data.
Q <sub>1</sub>	1	1	1	Relevant effect (mortality).
Q <sub>2</sub>	3	3	3	Study duration was acute
Q <sub>3</sub>	3	3	3	LD <sub>50</sub>
U	3	3	3	Old study, secondary source (supporting info only)
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	39	39	39	QCE = quantified critical endpoint
TRV	0.48	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.48	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Arsenic CAS 7740-38-2

**Test Organisms:** Domestic sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Eisler, R. 1988, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, US Fish and Wildlife Service Biological Report, 85(1.12):92pp.

**QCE:** 2.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q <sub>1</sub>	1	1	1	Relevant effect.
Q <sub>2</sub>	2	2	2	Subacute duration.
Q <sub>3</sub>	1	1	1	NOEL endpoint.
U	3	3	3	Secondary source, only one dose level.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.04	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral in diet (Arsenic as sodium arsenite)

**Test Endpoint:** NOAEL

**Reference:** U.S. Fish and Wildlife Service. 1964. Pesticide-wildlife studies, 1963: a review of Fish and Wildlife Service investigations during the calendar year. FWS Circular 199.

**QCE:** 5.14 mg/kg-day— $((51.35 \text{ mg As/kg food}) * (0.1 \text{ kg food/day})) / (1 \text{ kg BW})$

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Same trophic level but different order than members of functional groups
I	2	2	2	
Q <sub>1</sub>	1	1	1	Mortality, is ecologically relevant
Q <sub>2</sub>	1	1	1	Chronic duration (over 128 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Multiple doses (100, 250, 500, and 1000 ppm sodium arsenite) examined with both a NOAEL and a LOAEL established. However, no reproductive endpoints examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.14	5.14	5.14	QCE = quantified critical endpoint
TRV	1.29	0.64	0.43	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.29	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.64	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.43	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet as sodium arsenite or sodium arsenate

**Test Endpoint:** NOAEL

**Reference:** Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.

**QCE:** 1.28 mg/kg-day— (50 mg/kg food)\*(0.24 kg food /day)/(9.41 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Reasonable number of males and females studied (24)
Q <sub>1</sub>	1	1	1	Weight loss, survival, endpoint ecologically significant
Q <sub>2</sub>	1	1	1	Chronic study (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Reasonable study, but no reproductive endpoints examined in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.28	1.28	1.28	QCE = quantified critical endpoint
TRV	0.32	0.16	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.32	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate specified

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet as sodium arsenate or sodium arsenite

**Test Endpoint:** NOAEL

**Reference:** Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.

**QCE:**  $3.1 \text{ mg/kg-day} - (62.5 \text{ mg/kg food}) * (0.0189 \text{ kg/day}) / (0.382 \text{ kg BW})$

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	300 weanling Data do not show a good dose-response curve low-dose range.
Q <sub>1</sub>	1	1	1	Levels of 62.5 ppm Arsenic as arsenite and 125 ppm Arsenic as arsenate did not cause common bile duct enlargement and did not affect survival. Weight was slightly reduced in females at the 62.5 ppm Arsenic as arsenite.
Q <sub>2</sub>	1	1	1	Chronic study.
Q <sub>3</sub>	1	1	1	NOAEL using lowest NOAEL from either arsenite or arsenate
U	2	2	2	Good overall design, but no reproductive studies in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.1	3.1	3.1	QCE = quantified critical endpoint
TRV	0.78	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.78	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.27	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Mice (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet as sodium arsenate or sodium arsenite

**Test Endpoint:** LOAEL

**Reference:** Schroeder, H.A., and M. Mitchner, 1971. *Toxic effects of trace elements on the reproduction of mice and rats*. Arch. Environ. Health. 23:102-106.

**QCE:** 1.25 mg/kg-day— $((5.00 \text{ mg As/L H}_2\text{O}) * (0.0075 \text{ L/day})) / (0.003 \text{ kg BW})$

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	3 generations, however only one dosage
Q <sub>1</sub>	1	1	1	Declining litter sized with each successive generation
Q <sub>2</sub>	1	1	1	Chronic study.
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Only one dose level, no NOAEL established.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	0.16	0.08	0.052	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.16	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.052	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

## Benzo(a)pyrene

**COPC:** Benzo(a)pyrene CAS 50-32-8

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** FEL

**Reference:** Klein, M., 1963. "Susceptibility of Strain B6AF/j Hybrid Infant Mice to Tumorigenesis with 1,2-Benxanthracene, deoxycyclic acid, and 3-methylcholanthrene", *Cancer Research*, 23:1701-1707.

**QCE:** 500 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Infant males tested.
Q <sub>1</sub>	0.1	0.1	0.1	Cancer endpoint
Q <sub>2</sub>	1	1	1	Chronic (547-day) study
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Statistical evaluation of data not reported. Number of animals tested not reported.
Total AF	1.8	3.6	5.4	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	500	500	500	QCE = quantified critical endpoint
TRV	278	139	92.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	278	Test organism is in the same order and trophic level as the functional group members	none
2	139	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	92.6	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322



## Beryllium

**COPC:** Beryllium (Beryllium sulfate) CAS 7440-41-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Water

**Test Endpoint:** NOAEL

**Reference:** Schroeder, H.A., and M. Mitchner, 1975, *Life-Term Studies in Rats: Effects of Aluminum, Barium, Beryllium and Tungsten*, J. Nutr. 105: 421-427.

**QCE:** 0.66mg/kg-day—(5mg/L water)\*(0.046L/day)/0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (life-span, growth).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined
M	0.5	0.5	0.5	Soluble salt in the drinking water used
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.66	0.66	0.66	QCE = quantified critical endpoint
TRV	0.66	0.33	0.22	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.66	Test organism is in the same order and trophic level as the functional group members	None
2	0.33	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.22	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*Ingestion rate specified by EPA (EPA, 1985a).

## Cadmium

**COPC:** Cadmium CAS 7440-43-9

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL—Body weight gain, mortality

**Reference:** Pritzel, M.C., Y.H. Lie, E.W. Kienholz, and C.E. Whiteman, 1974, *The Effect of Dietary Cadmium on the Development of Young Chickens*, Poultry Sci. 53:2026-2029.

**QCE:** 29 mg/kg-day (400mg/kg)\*(0.11kg/day)/0.151 kg bw

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males tested, 100
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (growth, mortality).
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	3	3	3	LOAEL endpoint, but mortality observed
U	3	3	3	No reproductive endpoints examined, however, sensitive life stage examined. High doses tested. Presence of zinc in diet may have influenced (decreased) cadmium toxicity. NOAEL not identified.
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	29	29	29	QCE = quantified critical endpoint
TRV	0.81	0.40	0.27	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.81	Test organism is in the same order and trophic level as the functional group members	none
2	0.40	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.27	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Ingestion rate specified

\*\*BW estimated through the Rosomer article, 1961.

**COPC:** Cadmium CAS 7440-43-9

**Test Organisms:** Black Duck (Herbivore, Order-Anseriformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Heinz, G.H. and Haseltine, S.D., 1983, "Altered Avoidance Behavior of Young Black Ducks Fed Cadmium". *Environ. Toxicol. Chem.* 2:419-421. As cited in Eisler, 1985.

**QCE:** 0.14 mg/kg-day—(4 mg/kg)\*(0.06 kg/day)/1.7 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested, males, females and juveniles given the doses.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (behavior).
Q <sub>2</sub>	1	1	1	Chronic (90-day) exposure
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Reproductive endpoints and sensitive life stage examined, but only data given was on the flight response of the juveniles.
M	0.5	0.5	0.5	Cadmium chloride in the feed
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.07	0.04	0.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.07	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.02	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Cadmium CAS 7440-43-9

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Wills, J.H., Groblewski, G.E., Coulston, F., 1981, *Chronic and Multigeneration Toxicities of Small Concentrations of Cadmium in the Diet of Rats*, Ecotoxicol. Environ. Safety. 5:452-464.  
ATSDR, Agency for Toxic Substance Disease Registry, 1989, *Toxicological Profile for Cadmium*, March, 1989.

**QCE:** 5.5 E-3 mg/kg-day—Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males females and juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth, mortality).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	Excellent design, four-generational study.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.5E-3	5.5E-3	5.5E-3	QCE = quantified critical endpoint
TRV	3E-3	1E-3	8E-4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3E-3	Test organism is in the same order and trophic level as the functional group members	none
2	1E-3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8E-4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

## Chromium(III)

**COPC:** Chromium(III) CAS 7440-47-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Ivankovic and Preussmann, 1975, *Absence of Toxic and Carcinogenic Effects After Administration of High Doses of Chromic Oxide Pigment in Subacute and Long-Term Feeding Experiments in Rats*, Food Cosmet. Toxicol., 13(3): 347-351.

**QCE:** 1500 mg/kg-day—1800 g/kg total dose consumed at highest dose rate, administered 5 days/week for 120 weeks (~840 days total), corrected for % Cr.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q <sub>1</sub>	1	1	1	No endpoint affected (treatments had no effect on life expectancy, food consumption, growth rate, or cancer incidence).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1500	1500	1500	QCE = quantified critical endpoint
TRV	750	375	250	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	750	Test organism is in the same order and trophic level as the functional group members	none
2	375	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	250	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chromium(III) CAS 7440-47-3

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Romoser, G.L., W.A. Dudley, L.J. Machlin, and L. Loveless, 1961, *Toxicity of Vanadium and Chromium for the Growing Chick*, Poultry Science, 40:1171-1173.

**QCE:** 49 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Primary source available
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth, mortality).
Q <sub>2</sub>	2	2	2	Subchronic exposure duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Old study, limited endpoints
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	49	49	49	QCE = quantified critical endpoint
TRV	4.1	2.0	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.1	Test organism is in the same order and trophic level as the functional group members	none
2	2.0	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	1.4	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

## Chromium(VI)

**COPC:** Chromium(VI) CAS 7440-47-3

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Water

**Test Endpoint:** NOAEL

**Reference:** Steven et al. (1976) cited in Eisler (1986)

Anwar, R.A., et al., 1961, "Chronic Toxicity Studies. Part III. Chronic Toxicity of Cadmium and Chromium in Dogs", *Archives of Environmental Health*, 3:456-460.

Steven, J.D. et al., 1976, *Effects of Chromium in the Canadian Environment*, RCC No. 15017, National Resources Council, Ottawa, Canada.

**QCE:** 0.30 mg/kg-day—11.2 mg/L\*(3.1mL\*\*/100g-day)\*8730g\*1L/1000mL/8.73 Kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of female dogs only. No males tested.
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic duration (4 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint studied, but good duration of testing.
M	0.5	0.5	0.5	Soluble salt placed in the drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.30	0.30	0.30	QCE = quantified critical endpoint
TRV	0.15	0.08	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.05	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*\*Water consumption information is from the Dames and Moore animal data chart.

**COPC:** Chromium(VI) CAS 7440-47-3  
**Test Organisms:** Mouse (Omnivore, Order-Rodentia)  
**Exposure Medium:** Water  
**Test Endpoint:** FEL  
**Reference:** Trivedi, B., et al., 1989, "Embroyotoxicity and fetotoxicity of orally administered hexavalent chromium in mice," Reproductive Toxicology, 3(4);275-278.  
**QCE:** 59 mg/kg-day—Specified from 1.76 mg/mouse-day and a BW of .030 kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, variability assessed appropriately and not high.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic exposure duration
Q <sub>3</sub>	3	3	3	FEL endpoint - fetal development harmed
U	2	2	2	Well designed study, appropriate endpoints well characterized, but no NOAEL identified.
M	0.5	0.5	0.5	Soluble salt placed in the drinking water
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	9.8	4.9	3.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.8	Test organism is in the same order and trophic level as the functional group members	none
2	4.9	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322



## Cobalt (cobalt chloride)

**COPC:** Cobalt (cobalt chloride) CAS 7440-48-4

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL Increased mortality associated with *S. gallinarium* infection

**Reference:** Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," Journal of Nutrition, 109:501-507.

**QCE:** 10.2 mg/kg-day—100 ppm in diet converted to dose using an ingestion rate\* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.638	0.319	0.213	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.638	Test organism is in the same order and trophic level as the functional group members	none
2	0.319	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.213	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Estimated as  $0.0582 \text{ Wt}^{0.651}$  (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

## Cobalt

**COPC:** Cobalt CAS 7440-48-4

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiol. 128:345-348.

Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

**QCE:** 5.0 mg/kg-day—Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q <sub>1</sub>	0.1	0.1	0.1	Endpoint of unknown ecological significance
Q <sub>2</sub>	2	2	2	Subchronic duration (4 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	4.2	2.1	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.2	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Cobalt CAS 7440-48-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," Neurobehav. Toxicol. and Teratology, 5:9-15.

Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

**QCE:** 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q <sub>1</sub>	1	1	1	Endpoint of relevant ecological significance
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322